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COMPARISON OF NATIONAL STATE-OWNED ENTERPRISE AND GLOBAL COMPANY: CASE STUDY OF EFFICIENCY IN FERTILIZER PRODUCERS

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Abstract: Efficiency for fertilizer producers is critical in facing national and global competition. This study compares the efficiency of national fertilizer producing State-Owned Enterprises (SOE) companies with global fertilizer companies in different market structures. This research uses purposive sampling, namely world fertilizer producers (based on the top 10 in revenue or net profit) and SOE producers. This quantitative research uses the Data Envelopment Analysis (DEA) method on national and global companies from 2015 to 2021. The research results show that no national fertilizer producer was efficient compared to all global producers in the research period. It shows that the domestic oligopoly market structure tends to be inefficient compared to the global perfect competition market structure. Efficient global companies, including CF Industries, PhosAgro, Yara International, Sinofert, and Nutrien, can be used as benchmarks for national companies to increase their competitiveness. When we compare the efficiency among national companies, Petrokimia Gresik (PKG) and Pupuk Kalimantan Timur (PKT) are efficient. The inequality/disparity in efficiency at the national and global level is relatively high, so it is necessary to take strategies such as guaranteeing the availability of fertilizer raw materials in the long term, controlling market share, revitalizing more efficient fertilizer factories, and optimizing the supply chain from upstream to downstream.

Keywords: data envelopment analysis, fertilizer, state-owned enterprise, fertilizer producers

Abstrak: *Efisiensi bagi produsen pupuk sangat penting dalam menghadapi persaingan nasional dan global. Penelitian ini membandingkan efisiensi perusahaan Badan Usaha Milik Negara (BUMN) produsen pupuk nasional dengan perusahaan pupuk global pada struktur pasar yang berbeda. Penelitian ini menggunakan purposive sampling yaitu produsen pupuk dunia (berdasarkan 10 besar pendapatan atau laba bersih) dan produsen BUMN. Penelitian kuantitatif ini menggunakan metode Data Envelopment Analysis (DEA) pada perusahaan nasional dan global pada tahun 2015 hingga 2021. Hasil penelitian menunjukkan bahwa tidak ada produsen pupuk nasional yang efisien dibandingkan seluruh produsen global pada periode penelitian. Hal tersebut menunjukkan bahwa struktur pasar oligopoli domestik cenderung tidak efisien dibandingkan dengan struktur pasar persaingan sempurna global. Perusahaan global yang efisien antara lain CF Industries, PhosAgro, Yara International, Sinofert, dan Nutrien dapat dijadikan benchmark bagi perusahaan nasional untuk meningkatkan daya saingnya. Jika kita membandingkan efisiensi antara perusahaan nasional, Petrokimia Gresik (PKG) dan Pupuk Kalimantan Timur (PKT) termasuk yang efisien. Ketimpangan/disparitas efisiensi di tingkat nasional dan global relatif tinggi sehingga perlu dilakukan strategi seperti menjamin ketersediaan bahan baku pupuk dalam jangka panjang, menguasai pangsa pasar, merevitalisasi pabrik pupuk yang lebih efisien, dan mengoptimalkan rantai pasok dari hulu hingga hilir.*

Kata kunci: *data envelopment analysis, pupuk, BUMN, produsen pupuk*

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INTRODUCTION

The fertilizer industry will continue to face a challenging environment and actively seek new markets, diversify its range of higher-value products, and strive to achieve operational excellence (FitchSolutions, 2019). Several global fertilizer players are now investing significantly in digital solutions to find new sources of growth and are preparing to adopt agro-tech among farmers in developed markets (FitchSolutions, 2019). World fertilizer players who are global and local competitors are based on the value of revenue and operating profits, as shown in Table 1.

However, the Indonesia SOE fertilizer producers' income is derived significantly from subsidized fertilizer sales. Subsidies are a common policy in African countries and India, and is likewise present in Indonesia (Hernandez and Torero, 2013; FitchSolutions, 2019). SOE fertilizer producers are assigned to procure and distribute subsidized fertilizer or Public Service Obligation (PSO) fertilizer for the agricultural sector. Data from the SOE Annual Report of fertilizer producers in 2021 shows that the SOE fertilizer producers' income is primarily comprises from an average PSO income of around 60%, as seen in Table 2. It shows the company's dependence on subsidies, which has the potential to indicate the weak competitiveness of SOE fertilizer producers (FitchSolutions, 2019; Pupuk Indonesia, 2019). Apart from that, the world fertilizer industry is currently facing quite challenging conditions. The increasing fertilizer supply on the international market has caused fertilizer prices, especially urea, to experience a sharp decline. Due to many fertilizer factories in the world having been completed and the utilization of existing fertilizer factories has not been optimal, they increased fertilizer world supply (Fertecon, 2019). In addition, urea is a commodity, so it follows market price fluctuations, while NPK, as a compound fertilizer, has a formula according to plant needs (not as a commodity). It is a challenge that SOE fertilizer producers must face (FitchSolutions, 2019).

Competitiveness, especially related to efficiency, is a crucial word for facing global competition. It concerns the efficiency of fertilizer producers if the Government of Indonesia removes the subsidized fertilizer policy, and thus the SOE fertilizer companies will face global competition. The definition of competitiveness is at the country level (Schwab and World Economic Forum, 2019; Pérez-Moreno et al. 2016), industry level (Samuelson et al. 2021; Porter, 2008); and firm level (Wheelen et al. 2017; Porter, 1998; Jiang et al. 2016; Kiveu et al. 2019). The competitiveness of various industries that support the national economy influences a country's competitiveness, while the competitiveness of companies operating in that industry determines the industrial level of competitiveness. The measures of competitiveness at each level are different. At the country level, the indicator commonly used to measure the level of competitiveness is the Global Competitiveness Index (GCI), published annually by the World Economic Forum (WEF). Meanwhile, the competitiveness indicators used at the company level include the ability to generate profits (profitability), cost efficiency, productivity, and market share (Ravelomanantsoa et al. 2020).

Table 1. Global fertilizer companies in the world

Company	Country	Revenue (USD Million 2019)	Company	Country	Profit (USD Million 2019)
Nutrien	Canada	20,023	Uralkali	Russia	1,207
Yara International	Norway	12,858	Nutrien	Canada	992
The Mosaic Company	AS	8,906	PhosAgro	Russia	797
OCP Group	Morocco	5,636	CF Industries	AS	646
Israel Chemicals	Israel	5,271	Yara International	Norway	589
Pupuk Indonesia	Indonesia	5,130	Israel Chemicals	Israel	481
CF Industries	AS	4,590	SAFCO	Saudi Arabia	393
K+S Group	German	4,560	OCP Group	Morocco	314
PhosAgro	Russia	4,002	Pupuk Indonesia	Indonesia	267
Sinofert Holdings	China	3,285	K+S Group	German	100

Source: Pupuk Indonesia (2019)

Table 2. Contribution of PSO sales to total sales of SOE fertilizer producers

Company	Description	2017	2018	2019	2020
Pupuk Kalimantan Timur (PKT)	PSO sales (ton)	1,711,666	1,610,416	1,291,109	1,228,455
	Non-PSO sales	2,262,119	2,784,737	2,833,107	3,465,417
	Total sales	3,973,785	4,395,153	4,124,216	4,693,871
	% PSO	43	37	31	26
Petrokimia Gresik (PKG)	PSO sales (ton)	4,965,528	5,218,419	5,192,362	4,626,074
	Non-PSO sales	625,448	551,733	791,922	961,794
	Total sales	5,590,976	5,770,224	5,984,285	5,587,867
	% PSO	89	90	87	83
Pupuk Sriwidjaja Palembang (PSP)	PSO sales (ton)	1,440,916	1,371,317	1,206,450	1,313,744
	Non-PSO sales	1,085,846	1,070,003	886,351	1,103,944
	Total sales	2,526,762	2,441,319	2,092,801	2,417,688
	% PSO	57	56	58	54
Pupuk Kujang (PKC)	PSO sales (ton)	783,302	756,042	752,970	923,515
	Non-PSO sales	478,663	412,765	424,418	455,685
	Total sales	1,264,965	1,168,807	1,177,388	1,379,200
	% PSO	62	65	64	67
Pupuk Iskandar Muda (PIM)	PSO sales (ton)	393,545	383,972	266,022	338,327
	Non-PSO sales	53,648	43,196	35,309	56,335
	Total sales	447,193	427,169	301,330	394,663
	% PSO	88	90	88	86

Source: Pupuk Indonesia (2019)

Some academic literature states that SOEs are inefficient compared to privately owned enterprises (Belloc, 2014). Factors that make SOEs inefficient are the tendency to ignore market signals, soft budget constraints, weak management, agency problems, hierarchical costs, information asymmetries that occur, political intervention, and lack of innovation (Stan et al. 2014; Bruton et al. 2015; Liang et al. 2015; Lin et al. 2020). Several efficiency studies in domestic industries or companies use the DEA analysis (Nasir et al. 2018; Aruddy et al. 2019; Sinaga et al. 2021). The following studies regarding efficiency in fertilizer companies with comparative and integrative analyses by Kliopova et al. (2016), economic efficiency in phosphate mining by Steiner et al. (2015), technical efficiency in SOE Indonesian fertilizer with DEA by Destiartono and Purwanti (2021), energy efficiency in Indonesian fertilizer companies by Dzikrurrokhim (2021), efficiency using SFA in Indian fertilizer companies by Khan (2018), efficiency of fertilizer use in agriculture Arabic using the maximum likelihood method by Huang and Jiang (2019) and the efficiency of fertilizer companies in India using Fuzzy-DEA by Kumar et al. (2017). Previous studies still need to be more comprehensive in comparing global fertilizer companies and national fertilizer companies, which have different market structures. This study compares the efficiency of state-owned fertilizer producers in Indonesia with global fertilizer companies in different market structures. Previous research focused on perfectly competitive markets (Kliopova et al. 2016; Steiner et al. 2015; Khan 2018; Huang and Jiang 2019; and Kumar et al. 2017). In this research, the focus is on comparative oligopoly market structures in domestic and perfectly competitive markets in the global.

METHODS

This research uses a quantitative approach with the Data Envelopment Analysis (DEA) method. The type of data used in the research is secondary data from the financial reports of Indonesian SOE fertilizer-producing and multinational companies. The research uses non-probability for data collection techniques with purposive sampling with the criteria: BUMN fertilizer producers (domestic) and the top 11 world fertilizer producers in terms of highest revenue or profit in 2019. The data used are by the SOE fertilizer producers PT Pupuk Kalimantan Timur (PKT), PT Petrokimia Gresik (PKG), PT Pupuk Sriwidjaja Palembang (PSP), PT Pupuk Kujang (PKC), and PT Pupuk Iskandar

Muda (PIM) as well as ten global fertilizer producing companies, namely CF Industries (US), PhosAgro (Russia), Yara (Norway), Sinofert (China), Israel Chem (Israel), K+S Group (Germany), SAFCO (Saudi Arabia), Mosaic (US), Nutrien (Canada) and Uralkali (Russia) in the 2015-2021 period.

There are two approaches for calculating efficiency: (1) using a parametric method, namely the Stochastic Frontier Approach (SFA), and (2) using a non-parametric method, namely Data Envelopment Analysis (Coelli et al. 2005; Silva et al. 2020). Relative efficiency measures, both using input and output approaches, require defining a frontier that shows certain companies are relatively the most efficient compared to similar groups. Data Envelopment Analysis (DEA) calculates the relative efficiency of a unit in a group against the performance of th best unit in the same group. DEA is usually used to measure efficiency and can be used to assess the performance of a unit.

Measuring efficiency with the DEA method uses input and output variables. DEA is a non-parametric approach that is reliable for broad applications and is easy to carry out in connection with an economic definition that focuses on output capacity and does not require complex data (Cooper et al. 2011). Researchers can overcome efficiency measurements using multiple inputs and outputs by using weighted relative efficiency, but these measurements still have limitations in determining balanced weights for input and output (Cooper et al. 2011). In DEA, efficiency is the target to achieve maximum efficiency with the relative constraint that the efficiency of all units must not exceed 100%. The formula and input/output are as follows:

$$maximize\ \theta = \frac{u_1 y_{1o} + u_2 y_{2o} + \cdots + u_r y_{ro}}{v_1 x_{1o} + v_2 x_{2o} + \cdots + v_r y_{mo}} = \frac{\sum_{r=1}^{s} u_r\, y_{ro}}{\sum_{i=1}^{m} v_i\, x_{io}}$$

$\Sigma^{n}_{j} = 1X_{ij}$ 'ij $\geq \theta i0$ i = 1, 2, 3 …, m
$\Sigma^{n}_{j} = 1Y_{rj}$ 'j $\geq yi0$ r = 1, 2, 3 …, s
$\Sigma^{n}_{j} = 1$ 'j ≥ 0 j = 1, 2, 3 …, n

Where: θ (Efficiency (Constant Retun to Scale)); n (Number of decision-making unit (DMU)); m (Number of inputs); (Number of outputs); X_{ij} (Number of input type i^{th} of DMU j^{th}); Y_{rj} (Number of output type r^{th} of DMU j^{th}); 'j (DMU weight of j for the calculated DMU).

In this study, Table 3 shows company input and output in measuring efficiency with DEA. The input variables consist of Cost of Goods Manufactured (COGM) to total costs; Sales, General, and Administrative (SGA) costs to total costs; finance expense to total costs; and employee costs to total costs. In contrast, the output variable consists of net sales to total assets, net profit margin to total assets, and ROE to total assets.

The hypothesis used in this research compares each fertilizer producer with all fertilizer producers and each state-owned fertilizer producer with all state-owned fertilizer producers, with analysis per year and ignoring year, as in Table 4.

Table 3. Company, input, and output in measuring efficiency with DEA

Company		Input/Output
National SOE	**Global Company**	**Input**
PT Petrokimia Gresik (PKG)	CF Industries (US)	COGM/Total Cost
PT Pupuk Kalimatan Timur (PKT)	PhosAgro (Rusia)	SGA Cost/Total Cost
PT Pupuk Sriwidjaja Palembang (PSP)	Yara (Norwegia)	Finance Expense/Total Cost
PT Pupuk Kujang (PKC)	Sinofert (China)	Employee Cost/Total Cost
PT Pupuk Iskandar Muda (PIM)	Israel Chem (Israel)	**Output**
	K+S Group (Germany)	Net Sales/Total Asset
	SAFCO (Saudi Arabia)	Net Profit Margin/Total Asset
	Mosaic (US)	ROE/Total Asset
	Nutrien (Canada)	
	Uralkali (Rusia)	
	OCP Group (Morocco)	

Table 4. Research hypothesis

Efficiency comparison	To all global fertilizer producers	To all national SOE fertilizer producers
Per year 2015 2016 2017 2018 2019 2020 2021	H0: Fertilizer company N is inefficient compared to all global fertilizer producers in year t Hn: Fertilizer company N is efficient compared to all global fertilizer producers in year t (112 hypotheses = 16 companies' data x 7 years) Example: H0: PKG is inefficient compared to all global fertilizer producers in 2015 H1: PKG is efficient compared to all global fertilizer producers in 2015	H0: Fertilizer company N is inefficient compared to all national SOE fertilizer producers in year t Hn: Fertilizer company N is efficient compared to all national SOE fertilizer producers in year t (35 hypotheses = 5 companies' data x 7 years) Example: H0: PKG is inefficient compared to all national SOE fertilizer producers in 2015 H1: PKG is efficient compared to all national SOE fertilizer producers in 2015
Ignore the year 2015 – 2021	H0: Fertilizer company N is inefficient compared to all global fertilizer producers in 2015 – 2021 Hn: Fertilizer company N is efficient compared to all global fertilizer producers in 2015 - 2021 (112 hypotheses = 16 companies' data x 7 years) Example: H0: PKG is inefficient compared to all global fertilizer producers in 2015 - 2021 H1: PKG is efficient compared to all global fertilizer producers in 2015 – 2021 Note: N = (1) PKG, (2) PKT, (3) PSP, (4) PKC, (5) PIM, (6) SAFCO, (7) CF Industries, (8) Mosaic, (9) PhosAgro, (10) OCP Group, (11) Yara International, (12) Sinofert, (13) Nutrien, (14) Israel Chem, (15) Uralkali, (16) K+S Group	H0: Fertilizer company N is inefficient compared to all national SOE fertilizer producers in 2015 – 2021 Hn: Fertilizer company N is efficient compared to all national SOE fertilizer producers in 2015 – 2021 (35 hypotheses = 5 companies' data x 7 years) Example: H0: PKG is inefficient compared to all national SOE fertilizer producers in 2015 – 2021 H1: PKG is efficient compared to all national SOE fertilizer producers in 2015 – 2021 Note: N = (1) PKG, (2) PKT, (3) PSP, (4) PKC, (5) PIM

RESULTS

Descriptive Analysis of Input – Output for National and Global Companies

Descriptive analysis compares input and output for all global and national fertilizer producers, global fertilizer producers, and national fertilizer producers. Based on Table 5, COGM is the most dominant cost component in the fertilizer manufacturing industry for global and national fertilizer producers, namely an average of 83.6% of total costs with a standard deviation of 13.39%. Global fertilizer companies have an average COGM of 79.53% of total costs, with a standard deviation of 15.20%. In comparison, Indonesian SOE fertilizer-producing companies' average production cost is 90.76% of total costs, with a standard deviation of 2.50%. It shows that national fertilizer producers' production costs are higher than global fertilizer producers' average production costs. The gas raw material makes up around 70% of COGM urea, and it has been a long-term gas purchase contract. In addition, Indonesian gas prices are relatively high compared to several countries, as in Figure 1 (Pupuk Indonesia, 2022). Gas raw materials make up the bulk of urea fertilizer production costs. The lower the price of gas raw materials, the lower the production costs.

Table 5 shows that the production costs of national fertilizer producers are higher than the average production costs of world fertilizer producers. Gas raw materials largely influence urea fertilizer production costs (Fertecon, 2020). The lower the gas raw materials price, the lower the production costs. Figure 1 illustrates gas prices in several countries.

Table 5. Description of DEA input statistics

Variable	N	Mean	SD	Median
All global and national fertilizer producers				
Employee Cost to Total Cost	112	12.01	11.05	9.61
Cost of Goods Manufactured to Total Cost	112	83.6	13.39	88.49
Sales, General Administrative to Total Cost	112	15.1	12.83	9.19
Financial Expense to Total Cost	112	2.88	24.57	3.05
Global producers				
Employee Cost to Total Cost	77	13.50	13.49	10.40
Cost of Goods Manufactured to Total Cost	77	79.53	15.20	80.60
Sales, General Administrative to Total Cost	77	18.45	14.96	18.49
Financial Expense to Total Cost	77	1.66	30.62	2.12
National producers				
Employee Cost to Total Cost	35	9.55	2.44	9.34
Cost of Goods Manufactured to Total Cost	35	90.76	2.50	91.31
Sales, General Administrative to Total Cost	35	9.24	2.22	8.74
Financial Expense to Total Cost	35	5.21	3.11	4.71

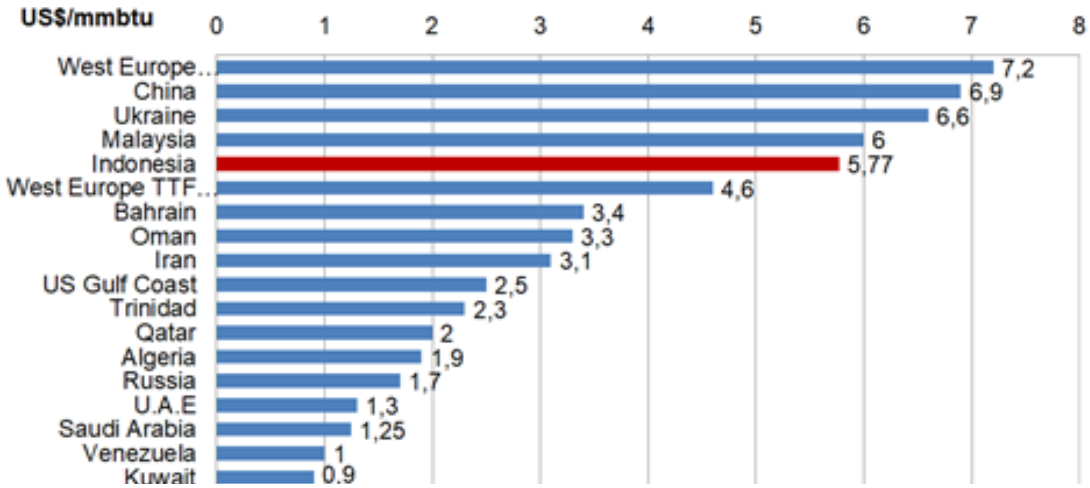

Figure 1. World gas prices in various countries (Fertecon, 2020)

The average employee cost for all global and national fertilizer producers is 12.01% of the total cost. Labor costs for national fertilizer producers are lower than for global fertilizer producers. It shows that the wages of Indonesian workers are relatively cheaper than foreign workers. There are several reasons why labor costs in Indonesia are cheap, namely (i) labor supply is excessive compared to labor demand in Indonesia, (ii) Regional Minimum Wages and GDP per capita are low compared to European countries and China, even they are lower than Malaysia and Thailand, (iii) the unemployment level is relatively high in Indonesia compared to world fertilizer producing countries (International Monetary Fund 2022; World Bank 2018).

The average marketing and administration costs (SGA costs) for all global and national fertilizer producers are 15.1% of the total costs, with a standard deviation of 12.83%. SGA costs for national fertilizer producers are lower than those for global fertilizer producers. It is because, currently, more national fertilizer producers carry out PSO assignments, and thus marketing costs are relatively lower than global fertilizer producers. As Table 2 above, from 2017 to 2020, the average of total PSO sales compared to total sales (in tons) for PKG was 87%, PKT 34%, PSP 56%, PKC 64%, and PIM 88%. As is widely known, more than 60% of SOE fertilizer products are for subsidized consumers (Pupuk Indonesia, 2020).

Furthermore, the average financial expense for all global and national fertilizer producers is 2.88%. The financial costs of national fertilizer producers are higher than those of global fertilizer producers. Financial costs are more related to interest expenses. Table 6 shows that interest expenses in Indonesia are relatively higher than in other world fertilizer-producing countries (www.ceicdata.com, 2023). Because national fertilizer producers have subsidy receivables that the government is still yet to pay, the company takes out working capital loans and incurs substantial interest charges. This is due to loan interest rates in Indonesia being more expensive compared to those found in other fertilizer-producing countries (Pupuk Indonesia, 2022).

Further descriptive analysis from the output side may be found in Table 7. If we look at the ability of the company's assets to generate net sales value or net sales to total assets (NSTA) for all global and national fertilizer producers, the average is 71.34%. Fertilizer producers worldwide vary quite a bit in their ability to generate revenue. Some producers managed to get the highest revenue (Sinofert in 2018) and the lowest (CF Industries in 2016 and Mosaic in 2021). In general, the ability of national fertilizer producers to generate revenue is lower than that of global fertilizer producers. In addition, the ability of national fertilizer producers to produce profit margins and ROE is lower than that of global fertilizer producers. This is mainly due to national fertilizer producers distributing a greater portion of its fertilizer to the food sector based on PSO assignments from the government as mentioned in Table 2. When fertilizer prices rise, the opportunity to make more significant sales to commercial consumers becomes limited because the available fertilizer has already been allocated for the PSO sector. Low sales capabilities and predetermined margins mean that national fertilizer producers must obtain optimal NPM or ROE when market prices rise (Pupuk Indonesia, 2022).

Table 6. Average loan interest rates in fertilizer-producing countries

Country	Average interest rate	Fertilizer Producer(s)
Russia	7.90%	PhosAgro, Uralkali
Indonesia	5.80%	PKT, PKG, PSP, PKC, PIM
China	4.36%	Sinofert Holdings
Morocco	2.45%	OCP Group
Saudi Arabia	2.03%	SAFCO
Norway	1.15%	Yara International
Canada	1.08%	Nutrien
US	0.80%	CF Industries, The Mosaic Company
Israel	0.64%	Israel Chemicals
German	0.26%	K+S Group

Source: www.ceicdata.com (2023)

Table 7. Description of DEA output statistics

Variable	N	Mean	SD	Median
All global and national fertilizer producers				
Net Sales to Total Asset	112	65.29	45.40	51.66
Net Profit Margin	112	9.58	18.42	5.86
Return on Equity	112	9.36	20.10	6.76
Global producers				
Net Sales to Total Asset	82	71.34	53.11	52.83
Net Profit Margin	82	11.14	21.88	6.64
Return on Equity	82	10.56	23.92	6.98
National producers				
Net Sales to Total Asset	35	52.33	14.63	50.38
Net Profit Margin	35	6.15	4.49	5.24
Return on Equity	35	6.71	5.44	5.11

DEA Analysis Comparison To All Global Producers

Analysis of the DEA efficiency of fertilizer producers per year is exhibited in Table 8. There are 112 hypotheses, with 38 hypotheses accepted and 74 hypotheses rejected. The highest number of companies in the efficient category occurred in 2016 and 2017, namely seven companies, while the lowest number of efficient categories occurred in 2021, namely four companies. The number of companies in the efficient category is still fewer than those in the inefficient category. There are several reasons why fertilizer companies are inefficient, namely: (i) the regional market structure of fertilizer producers, which is oligopoly, (ii) high economic scale or high investment in fertilizer companies, and (iii) government intervention regarding fertilizer for food security. A combined analysis of all global fertilizer companies and national fertilizer producers shows that no Indonesian national companies are in the efficient category from 2015 to 2021. We can see the low productivity of national companies from the comparison of their ability to make low sales and high input costs compared to world producers in general.

Table 8. List of companies with efficiency categories by year

Year	Category	Number	Company & the results of hypothesis
2015	Efficient	6	CF Industries (H7 accepted), PhosAgro (H9 accepted), Yara (H11 accepted), Sinofert (H12 accepted), Israel Chem (H14 accepted), K+S Group (H16 accepted)
	Not efficient	10	PKG (H1 rejected), PKT (H2 rejected), PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected), SAFCO (H6 rejected), Mosaic (H8 rejected), OCP Group (H10 rejected), Nutrien (H13 rejected), Uralkali (H15 rejected)
2016	Efficient	7	Mosaic (H8 accepted), PhosAgro (H9 accepted), Yara (H11 accepted), Sinofert (H12 accepted), Nutrien (H13 accepted), Uralkali (H15 accepted), K+S Group (H16 accepted)
	Not efficient	9	PKG (H1 rejected), PKT (H2 rejected), PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected), SAFCO (H6 rejected), CF Industries (H7 rejected), OCP Group (H10 rejected), Israel Chem (H14 rejected)
2017	Efficient	7	CF Industries (H7 accepted), PhosAgro (H9 accepted), Yara (H11 accepted), Sinofert (H12 accepted), Nutrien (H13 accepted), Israel Chem (H14 accepted), K+S Group (H16 accepted)
	Not efficient	9	PKG (H1 rejected), PKT (H2 rejected), PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected), SAFCO (H6 rejected), Mosaic (H8 rejected), OCP Group (H10 rejected), Uralkali (H15 rejected)
2018	Efficient	4	CF Industries (H7 accepted), Sinofert (H12 accepted), Nutrien (H13 accepted), Israel Chem (H14 accepted)
	Not efficient	12	PKG (H1 rejected), PKT (H2 rejected), PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected), SAFCO (H6 rejected), Mosaic (H8 rejected), PhosAgro (H9 rejected), OCP Group (H10 rejected), Yara (H11 rejected), Uralkali (H15 rejected), K+S Group (H16 rejected)
2019	Efficient	5	CF Industries (H7 accepted), PhosAgro (H9 accepted), Yara (H11 accepted), Sinofert (H12 accepted), Nutrien (H13 accepted)
	Not efficient	11	PKG (H1 rejected), PKT (H2 rejected), PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected), SAFCO (H6 rejected), Mosaic (H8 rejected), OCP Group (H10 rejected), Israel Chem (H14 rejected), Uralkali (H15 rejected), K+S Group (H16 rejected)
2020	Efficient	5	CF Industries (H7 accepted), PhosAgro (H9 accepted), Yara (H11 accepted), Sinofert (H12 accepted), Nutrien (H13 accepted)
	Not efficient	11	PKG (H1 rejected), PKT (H2 rejected), PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected), SAFCO (H6 rejected), Mosaic (H8 rejected), OCP Group (H10 rejected), Israel Chem (H14 rejected), Uralkali (H15 rejected), K+S Group (H16 rejected)
2021	Efficient	4	SAFCO (H6 accepted), CF Industries (H7 accepted), Yara (H11 accepted), Sinofert (H12 accepted)
	Not efficient	12	PKG (H1 rejected), PKT (H2 rejected), PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected), Mosaic (H8 rejected), PhosAgro (H9 rejected), OCP Group (H10 rejected), Nutrien (H13 rejected), Israel Chem (H14 rejected), Uralkali (H15 rejected), K+S Group (H16 rejected)

Also, efficient fertilizer producers tend to decline from 2015–2021. In this period before the COVID-19 pandemic, there were indications that the world fertilizer industry had an excess fertilizer supply, resulting in a downward trend in the price of fertilizer as a commodity. The level of efficiency of fertilizer companies globally is influenced by industrial conditions. In general, the global fertilizer industry is still showing a market demand growth trend of 1.4%, with several characteristic directions of global fertilizer market development as follows: (a) the nitrogen fertilizer market is a fertilizer market segment that is quite saturated with a market demand growth trend of 1.0% per year; (b) the market for Phosphate (P) and Potassium (K) fertilizers grew by 1.7% per year (Phosphate fertilizer) and 2.1% per year due to a shift in balanced fertilization patterns; (c) there has also been a shift to non-chemical fertilizers which has increased market growth for organic fertilizers and biofertilizers; (d) increasing environmental concern affects fertilizer production and application especially in China and Germany; (e) changes to the subsidy model are taking place in several countries such as Nigeria and India which will implement a direct transfer subsidy model to farmers (Fertecon, 2020; Pupuk Indonesia, 2022).

Next, a DEA efficiency analysis was carried out for all world and national producers, ignoring the grouping based on year, as shown in Table 9. There are 112 hypotheses with 8 hypotheses accepted and 104 hypotheses rejected. The optimal efficiency conditions for the fertilizer industry worldwide occurred in 2015. The supporting evidence is that in 2015 there were four fertilizer-producing companies worldwide with efficient categories: CF Industries, P hosAgro-, Yara International, and K+S Group. Yara International is the most efficient fertilizer producer and has recorded this feat three times, namely in 2015, 2019, and 2020. Yara focuses on fertilizer with added value and its value chain, in addition to diversifying industrial products by optimizing logistics (Yara, 2020).

Five global fertilizer producers can become benchmarks in the efficient category. Based on the DEA efficiency value at least five times throughout the 2015 – 2021 period, the five producers are CF Industries (6 times efficient), PhosAgro (5 times efficient), Yara International (6 times efficient), Sinofert (7 times efficient), and Nutrien (5 times efficient). Table 10 compares five global fertilizer producers as benchmarks in the efficient category.

DEA analysis comparison to all national SOE producers

The following is the DEA efficiency analysis of national fertilizer producers every year from 2015 to 2021, as seen in Table 11. There are 35 hypotheses with 14 hypotheses accepted while 21 hypotheses rejected. The result is that the number of companies included in the efficient category remains consistent every year from 2015 to 2021, namely PKT and PKG.

Table 12 shows the DEA efficiency analysis of national fertilizer producers, ignoring the grouping based on year in from 2015 to 2021. There are 35 hypotheses with 2 hypotheses accepted while 33 hypotheses rejected. The result is that the number of companies included in the efficient category remains consistent, namely PKT and PKG.

Table 9. All companies according to efficiency categories 2015 – 2021 (ignoring year)

Category	Number	Company & the results of hypothesis
Efficient	8	2015: CF Industries-2015 (H7 accepted), PhosAgro-2015 (H9 accepted), Yara-2015 (H11 accepted), K+S Group-2015 (H16 rejected); 2018: Sinofert-2018 (H12 accepted), Israel Chem-2018 (H14 rejected); 2019: Yara-2019 (H11 accepted); 2020: Yara-2020 (H11 accepted)
Not efficient	104	The remaining 104 companies' data and the hypothesis were rejected

Table 10. Comparison of five efficient global fertilizer producers

Description	CF Industries	Phos Agro	Yara International	Sinofert	Nutrien
Country	USA	Russia	Norway	China	Canada
Production capacity	- Ammonia 9.3 M Tons - Granular Urea 4.1 M Tons - Urea Ammonium Nitrate (UAN) 32% 6.7 M Tons - Ammonium Nitrate (AN) 1.6 M Tons	- Nitrogen Based Fertilizer 2.55 M Tons - Phosphate Based Fertilizer 8.2 M Tons	- Ammonia 8.5 M Tons - Nitric Acid (NA) 8.6 M Tons - Phospor Rock 1 Juta Ton - Phospor Acid 0.6 M Tons - Urea 5.3 M Tons - Nitrates 7.1 M Tons - NPK 6.6 M Tons - CN 1.6 M Tons - UAN 1 M Tons - MAP 0.6 M Tons	- Potash Fertilizer 1.69 M Tons - Nitrogen Fertilizer 2.87 M Tons - Phospate Fertilizer 1.94 M Tons - Compound Fertilizer 2.1 M Tons - Special Fertilizer 0.1 M Tons	- Potash Based - Fertilizer 14.8 M Tons - Nitrogen Based - Fertilizer 17.9 M Tons - Phospate Based Fertilizer 15.4 M Tons
Number of plants	7 Nitrogen Plant	6 Plant	28 Plant	13 Plant	20 Plant
Marketing area	Canada, US, UK	Russia, Europe, North & South America,	Russia, Europe, North & South America, Asia, Australia, Middle East	China	North & South America, Europe, Australia, Taiwan
Source of raw materials	US	Russia	Africa, Brazil,	Yordania, Belarus, Morocco, Tunisia, Canada	Canada, US, Trinidad
SOE/ Non SOE	Non SOE	Non SOE	Non SOE	Non SOE	Non SOE
Players in Indonesia	No	No	Yes	No	No

Table 11. National companies in efficiency categories per year (2015 to 2021)

Year	Category	Number	Company & the results of hypothesis
2015	Efficient	2	PKG (H1 accepted), PKT (H2 accepted)
	Not Efficient	3	PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected)
2016	Efficient	2	PKG (H1 accepted), PKT (H2 accepted)
	Not Efficient	3	PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected)
2017	Efficient	2	PKG (H1 accepted), PKT (H2 accepted)
	Not Efficient	3	PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected)
2018	Efficient	2	PKG (H1 accepted), PKT (H2 accepted)
	Not Efficient	3	PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected)
2019	Efficient	2	PKG (H1 accepted), PKT (H2 accepted)
	Not Efficient	3	PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected)
2020	Efficient	2	PKG (H1 accepted), PKT (H2 accepted)
	Not Efficient	3	PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected)
2021	Efficient	2	PKG (H1 accepted), PKT (H2 accepted)
	Not Efficient	3	PSP (H3 rejected), PKC (H4 rejected), PIM (H5 rejected)

Table 12. All national companies according to efficiency categories 2015 – 2021 (ignoring year)

Category	Number	Company & the results of hypothesis
Efficient	2	2015: PKG -2015 (H1 accepted), PKT -2015 (H2 accepted)
Not efficient	33	The remaining 33 companies' data and the hypothesis were rejected

They achieve economies of scale because PKT and PKG have large production capacities, wide market shares (marketing areas), and availability of raw materials. PKC, PIM, and PSP are in the non-efficient category of producers. Due to the old factory's smaller capacity, raw materials' availability has not been optimal. To increase productivity and competitiveness, PKC, PIM, and PSP, together with the parent company, must revitalize and increase factory capacity, ensure guaranteed availability of raw materials, and develop consumer-oriented marketing strategies. National fertilizer producers must take various steps to increase output whilst reducing input. This step must increase the efficiency ratio; namely, the value of output divided by input must be higher. Increasing output means increasing sales value (net sales), net profit margin (NPM), and return on equity (ROE). Meanwhile, reducing input can be done through efficiency or reducing various costs, namely employee costs, production costs (COGM), marketing costs, and financial costs.

Managerial implications

The inefficiency of national fertilizer companies compared to global fertilizer companies implies that SOE fertilizer producers need to make efforts to increase output (net sales, NPM, and ROE) and reduce input (various costs: production costs, labor costs, marketing costs, and financial costs). They can increase sales through cost leadership, namely by lowering production costs while maintaining product and service quality so that they can compete in the market, considering that currently, fertilizer is still a commodity item that is very vulnerable to changes in market prices. Indonesian SOE fertilizer producers can adopt strategies: (a) ensuring the long-term availability of fertilizer raw materials so that they can determine market control strategies, (b) revitalizing fertilizer factories to be more efficient, and (c) optimizing the entire supply chain from upstream to downstream. In addition, SOE fertilizer producers can make global companies, namely Yara International, CF Industries, PhosAgro, Sinofert, and Nutrien, and national fertilizer companies, namely PKT, as benchmarks in the national fertilizer industry.

National SOE fertilizer producers need to get support from the government, including (a) the government needs to provide a policy to fulfill the gas needs of the national fertilizer industry sustainably at economical prices that can increase the competitiveness of the national fertilizer industry, (b) the government needs to issue transitional regulations for accelerate the payment of fertilizer subsidy receivables to SOE fertilizer producers and the government can implement direct transfer to farmers mechanism which will minimize late payments to the SOE fertilizer producers as they meet all the prerequisites.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Fertilizer companies in perfectly competitive markets are more efficient than in oligopoly markets. National state-owned fertilizer companies are inefficient compared to global fertilizers. There exists a significant inequality/disparity regarding the efficiency of SOE fertilizer producers in Indonesia and global efficient fertilizer producers. Based on the results analysis of global and national fertilizer companies from 2015 to 2021, there are no efficient Indonesian state-owned fertilizer producers. In contrast, if the efficiency analysis is limited to all Indonesian state-owned fertilizer producers, only Pupuk Kalimantan Timur and Petrokimia Gresik are included in the list of efficient categories. Furthermore, based on the efficiency analysis results, 2015 is the most optimal condition for the global and national fertilizer industry because that year is still heading towards the balance of world fertilizer oversupply.

Recommendations

The proposed further research compares the efficiency of SOE with non-SOE companies in Indonesia and efficiency research by measuring economic deadweight loss from the inefficiency of SOE fertilizer producers.

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